FIRE STATION 31
HAZARDOUS MATERIALS TESTING

SUMMARY of the FINAL REPORT

Prepared for

FIRE STATION 31 HEALTH INVESTIGATION
INTERDEPARTMENTAL TASK FORCE

By PREZANT ASSOCIATES, INC.

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[Note: this is a condensed version of the full Final Report. The items that are missing in this version are indicated below]

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FINAL REPORT

I. EXECUTIVE SUMMARY

Prezant Associates, Inc. (Prezant) conducted extensive testing for a variety of airborne, surface, and soil health hazards at Fire Station 31 at the request of the City of Seattle. Based on our sampling and analytical results, the building as a whole appears safe for general occupancy. However, a few specific areas of the building were determined to contain lead above EPA recommended levels. This lead was present in soils in an open dirt area of the basement, and on walls and floors in several adjacent rooms. The soils should be covered or removed, and the walls and floors should be cleaned.

Other samples, notably the bacterial samples, indicated the presence of large numbers of bacteria in the dust. Because these types of bacteria typically live in puddled water, and rain was observed to be penetrating the bricks in many locations, it is likely that the high bacterial levels in the dust are related to water getting into the building. The bricks should be sealed with a non- or low-volatile organic compound sealant to minimize water infiltration. Once the bricks are sealed, the white powdery deposits caused by transport of water through the brick should be cleaned, as the powder contains quartz, a type of silica.

Residues of organochlorine pesticides were detected in the dirt in one indoor area and in two outdoor soil areas near the Station. The inside air should be tested for these types of pesticides and indoor dirt containing these contaminants should be cleaned.

Several of the fluorescent light ballasts contain PCBs. While there is no immediate health risk, these types of ballasts sometime fail, causing the contamination of indoor areas with PCBs. The PCB ballasts should be replaced.

While none of the individual VOCs measured exceeded any Permissible Exposure Limit, the concentration of several gasoline constituents and other solvent components were detected in the open soil area of the basement at levels several times higher than that measured outdoors. The source of these VOCs should be investigated further.

II. INTRODUCTION

During October through December 2003, Prezant Associates, Inc. (Prezant) conducted testing for a variety of airborne, surface, and soil health hazards at Fire Station 31 located in Seattle, Washington. The testing was conducted at the request of the City of Seattle, Office of the Mayor, to determine if there are hazardous chemicals, biological agents, or radiation that might present health risks to the firefighters based at Station 31. The main emphasis of the Prezant study was to determine if there are currently carcinogenic substances present, but other health hazards were studied as well. Concurrent panels studying epidemiology of firefighter illnesses and evaluating medical screening of firefighters have been formed. Consequently, this report is limited to presentation of the test results and recommendations for prevention of current health effects to the firefighters.

III. AREAS OF POTENTIAL HEALTH CONCERN

Based on the analytical results of over 250 samples collected from various areas in and around the Station, the following potential risks to firefighter health were identified by Prezant.

A. Lead

The basement of the Station contains several areas contaminated with lead dust. The main areas of concern are two dirt-covered rooms that appear to have been part of the basement of the original fire station that was constructed at the site in the 1950s. The current Station 31 was built over the original basement in 1974. The dirt-covered rooms were anecdotally used for indoor firing ranges by firefighters up until possibly the 1990's. As the rooms are not ventilated, it appears that the lead dust originating from the bullets fired from the guns accumulated on the soils and adhered to the concrete brick walls of the basement.

The walls of the West Storage Room and Laundry Room are also contaminated with lead, although to a lesser degree. No indications of any surface lead contamination were detected in the other basement rooms or in the first and second floor areas of the Station. Not a single test from among those conducted throughout the Station detected any airborne lead. Therefore, the health risk posed by the lead in the basement is likely limited to direct contact of the contaminated soils and surfaces by firefighters' hands, shoes, and clothing, and to accidental ingestion of the lead that might occur if their hands are not washed prior to eating, drinking, smoking, or other hand-to-mouth contact.

Testing of the drinking water for lead revealed lead levels well below established limits. However, the faucet supplying water for the sink used to fill the coffee pot in the Beanery had a lead concentration twice as high (0.002 mg/L) as the other sink in the Beanery used to wash dishes (0.001 mg/L). The lead is related to the internal surfaces of the faucet, and after water runs for a minute, the water contains the same lead concentration as from the other sink.

Recommendations for Lead

A-1. The heavily lead-contaminated areas of the basement should be immediately closed off to routine access. [This has already been done.]

A-2. The lead should be removed from the less-contaminated walls and surfaces of the adjoining rooms by washing followed by encapsulation with paint according to a protocol designed to prevent the spread of lead during the washing and painting. After this work is done, resampling of should be performed to verify that removable lead levels are below the current EPA limit for the floors of child-occupied residences.

A-3. A lead remediation work plan should be prepared the walls and soil-covered rooms of the basement. After review and approval by the City, the work plan should be implemented by trained lead abatement workers so that lead does not contaminate adjacent areas. Following completion of the lead remediation the air and surfaces of the Station should be retested for lead to verify that the cleanup is complete.

A-4. Let the water in the small sink run for a minute before filling the coffee machine or other water containers.

B. Organochlorine Pesticides

The use of organochlorine pesticides likely occurred in the past by firefighters doing routine landscaping or minor insect control work, or by City-hired pest control operators. One indoor area and two adjacent outdoor areas of the Station were tested for the presence of organochlorine pesticides. All three samples were positive for organochlorine pesticides.

The dirt at the base of the Hose Tower contained low concentrations of the insecticide DDT. The use of DDT was banned in the United States in 1973, although it is still in use in some other parts of the world. The soils of the planter area along the west exterior wall of the Station and the lawn area under the tree to the east of the Station both contained low concentrations of heptachlor epoxide and chlordane. Until 1983, chlordane was used in the United States as a pesticide on crops like corn and citrus and on home lawns and gardens. Because of concern about damage to the environment and harm to human health, the U.S. Environmental Protection Agency (EPA) banned all uses of chlordane in 1983 except to control termites. In 1988, EPA banned all uses of chlordane. Heptachlor was once used in the United States as a non-agricultural insecticide. Heptachlor epoxide is formed from heptachlor in the environment. Most uses of this insecticide were canceled in 1978. The only permitted commercial use of heptachlor products is for fire ant control in buried, pad-mounted electric power transformers and in underground cable television and telephone cable boxes.

Because these pesticides degrade very slowly over time, the current residual concentrations measured in the Hose Tower and outdoors are indicators of probable past application of those pesticides.

Recommendations for Organochlorine Pesticides

B-1. Only a very few samples were collected in this initial screening study, and the presence of organochlorine pesticides in three out of three samples indicates that there is a possibility that there might be additional contamination in other areas of the station. Further testing of the air inside the Station should be performed to determine if the organochlorine pesticides present a potential health risk to the firefighters. In addition, samples from the dust present in other areas of the Station should be tested for organochlorine pesticides to determine if they have been applied to additional areas.

B-2. Until the extent of contamination is defined, firefighters and other City or contractor work crews should not excavate site soils without proper protective equipment and provision for soil testing.

B-3. Once the pesticide sampling is completed, indoor areas with pesticide levels determined to present a potential health risk to firefighters should be cleaned. This cleaning should be done by a trained hazardous materials contractor in such a way that pesticide contamination does not spread to other areas of the Station. At the completion of the cleaning, additional testing should be performed to verify that the cleaning is complete.

C. Brick Walls

In an effort to stop the transmigration of water through the brick walls, multiple layers of sealants have been applied to the exterior surfaces of the Station. Analysis of the VOCs that are off-gassing from the

sealant indicates the presence of at least two potentially toxic chemicals: methylene chloride, and possibly acetaldehyde. Other tentatively identified compounds off-gassing from the sealant are not known to be hazardous. Since the sealant is on the exterior and is off-gassing into the general air, there does not appear to be an immediate health hazard to the firefighters who are occupying the station. However, at the times of original application of the sealant, it was possible that off-gassing was sufficient to affect the firefighters.

The red bricks that predominate the walls of the Station contain numerous areas of a white powdery substance. It tends to form when water enters the mortar on the exterior wall and passes through into the interior, where the water evaporates, leaving behind the powder. Analysis of the powder indicted the following major components: Quartz, sodium sulfate, potassium sodium sulfate, calcite. Other materials are likely present as well, but in quantities too small to identify. The potential health hazards of the powder are limited to those presented by the quartz, which is a form of crystalline silica. There is no current health risk presented by the quartz from the walls, as air sampling for silica throughout the station did not indicate its presence in the air. The other identified compounds are not known to be health hazards.

Recommendations for Brick Walls

C-1. There does not appear to be a need to remove the existing sealant from the bricks, as the quantities of VOCs that are off-gassing during the cooler winter months are most likely quite low. This is confirmed by the relatively low levels of sealant-related VOCs detected in the air inside the Station.

C-2. There are reports that pentachlorophenol may have been applied to the interior or exterior of the brick walls to retard mold growth in the past. Further testing of the air inside the Station should be performed to determine if any pentachlorophenol is off-gassing into the air of the Station.

C-2. Do not apply further coats of the types of sealants currently used on the bricks until a plan for measurement and control of off-gassing is prepared and evaluated by a Certified Industrial Hygienist.

C-3. The water infiltrating into the building during rainy days may be occurring because the bricks have not been sealed appropriately in the past. The bricks should be re-sealed when the weather is conducive to such application, but non-toxic and/or low-VOC sealants should be used so that extensive planning and air monitoring would not be necessary.

C-4. The powdery material forming on the bricks is not hazardous as long as it is not disturbed. Therefore, we recommend that the powder not be disturbed if at all possible while efforts are underway to determine a better method of sealing the bricks.

C-5. Once the bricks are properly sealed and water infiltration stops, the interior of the bricks where the white powder has been deposited should be cleaned off with a damp rag that is then immediately sealed into a plastic zip-lock bag and thrown into the routine Station trash bins. No protective gear is necessary for this cleaning, as long as it is done with a damp cloth. The powdery material should not be routinely vacuumed from the walls or floor.

D. Fluorescent Light Fixtures

Several fluorescent light fixtures in the basement were examined for the presence of PCB-containing light fixtures and associated PCB leakage. While all ballasts we observed were PCB-containing, none were leaking. Their is a possibility that the ballasts might fail in the future, in which case PCBs might leak or be spread into the Station.

No evidence was detected that the prior use of mercury-containing light tubes had contaminated the air or surfaces of the Station with mercury. Non-mercury tubes are now being used.

Recommendations for Fluorescent Light Fixtures

D-1. Replace the PCB-containing light ballasts throughout the Station with non-PCB ballasts.

D-2. Properly package and dispose of the PCB-containing ballasts.

E. Indoor Air Quality

The measurements made by Prezant indicated several extended periods when the recommended temperature, humidity, and carbon dioxide ranges were exceeded. Of particular note are the relatively high levels of carbon dioxide in the Paramedic Room at night. While these results primarily affect the comfort of firefighters, there are possible short-term health effects, such as increased susceptibility to common illnesses such as colds and bacterial infections. In addition, this survey was conducted during a relatively moderate autumn, so the out-of-range conditions might be worse during more extreme seasonal variations.

Recommendations for Indoor Air Quality

E-1. Retest the indoor air quality parameters during the colder portions of the winter, when the windows are more likely to be closed and the air is moister, and again in the summer, when the bricks retain their heat even during the nighttime hours.

E-2. Consider methods to increase ventilation in the Paramedic Room at night.

F. Volatile Organic Compounds

None of the identified VOCs exceeded any Permissible Exposure Limit. However, it was noted that the concentration of benzene in the open soil area of the basement is approximately 4 times higher than it is outdoors. Similar ratios appeared to be present for some of the other aromatic components of gasoline, namely ethylbenzene, toluene, and xylene. See Table 4 for a comparison of the indoor and outdoor VOC levels. It is possible that an underground storage tank containing gasoline has leaked into the underlying soils and is evaporating into the basement via the open soils. It is also possible that past disposal practices for cleaning solvents involved pouring into site soils or even into the basement soils themselves.

Recommendations for VOCs

F-1. Develop and implement a work plan to characterize the chemicals in the soils of the basement for VOCs. This study should also include more detailed metals analysis, as only lead has been sampled as part of our current efforts. See Part II.A above.

F-2. Based on the results of the soil sampling, options for dealing with contaminated soils may need to be developed and evaluated.

F-3. Retest for VOCs during the warmer summer months.

G. Mold and Bacteria

Molds grow well in moist conditions if organic materials are present. The Station's brick wall construction apparently allows rainwater to readily enter the building. There are very few organic building materials in the facility that could serve as food for the mold, and consequently, mold levels in the indoor air of the Station are about the same as those found naturally outdoors. We noted that the Hose Tower smells slightly musty, and we measured a slight increase in total mold spores in the Tower relative to outdoor mold spore levels. It is possible that the increase mold is supported by the drying fire hoses. However,

since there is no organic material incorporated into the actual Tower structure, it is unlikely that mold growth will become established in the Tower.

Localized mold growth was detected in the facility on typical surfaces such as shower stalls and window ledges, but the growth we detected is somewhat limited to the available dust and dirt that naturally accumulates on those surfaces.

Because of the limited quantity of materials in the building that could absorb water, the rainwater tends to puddle on floors. This presents an ideal growth situation for certain forms of bacteria, known as gram-negative bacteria that tend to flourish in wet environments even when no food source is present. Prezant has measured relatively high levels of these types of bacteria incorporated into the dust in several rooms, with the highest gram-negative bacterial levels found in the TV Room. These types of bacteria tend not to form spores, but can become airborne when the water evaporates. These types of bacteria also contain "endotoxins," which have been generally linked to various health complaints related to the indoor environment.

Because of the relatively high concentrations of gram-negative bacteria identified in the dust, Prezant performed endotoxin air sampling in the Station. Endotoxin results indicated that there were no elevated levels of endotoxins inside the Station.

Recommendations for Molds and Bacteria

G-1. Maintain a close watch for water leaks on the glue-on ceiling tiles; if they get wet, they would be an excellent food source for mold growth. If any tiles are observed to become stained or water-damaged, the leak causing the stain should be repaired and the tiles replaced.

G-2. When mopping the floor areas of the Station, use clean mops and a mild bactericide solution. Try to manually remove as much organic material, old wax buildup, and accumulated dirt from the cracks and crevices that the mops do not really touch.

G-3. Damp wipe shower stalls surfaces, sink areas, desktops, tabletops, countertops, windowsills, and other horizontal surfaces using a mild bactericide solution.

IV. SUMMARY OF MEASUREMENTS AND RESULTS

This section presents the entire scope of substances and agents tested in the Station, along with data tables presenting the highlights of the results. Appendix A presents the methods used in our study. Figures with sample locations and data tables presenting the results of all sampling are presented in Appendix B. The laboratory certificates of analysis are included as Appendices C and D, and calibration and equipment information is presented in Appendix E.

A. Airborne Carcinogens

Prezant tested the air inside and outside (for background comparison) for several known human carcinogens. All of the measured agents were below the specified Action Limit. See Table 1 for agents tested and the results. Descriptions of each health hazard follow Table 1. Laboratory certificates of analysis for each of these tests are presented in Appendix D.

Table 1 – Analytical Results for Airborne Carcinogens

Health Hazard	Action Limit	Result
Arsenic, inorganic	PEL 0.01 mg/m^3	Max 0.0068 mg/m^3
Asbestos	EPA 0.01 f/cc (background)	Max 0.007 f/cc
Benzene	REL 0.32 mg/m^3	Max 0.025 mg/m^3 (See Table 3)
Cadmium	PEL 0.005 mg/m^3	Max 0.00011 mg/m^3
Chromium, hexavalent	0.001 mg/m^3	Max 0.0007 mg/m3
Diesel particulate matter (DPM)	0.02 mg/m^3 as elemental carbon (ACGIH – withdrawn notice of intended change)	Max 0.0037 mg/m^3
Polycyclic aromatic hydrocarbons (PAHs)	REL 0.1 mg/m^3 as cyclohexane extractable fraction	Naphthalene: 0.00034 mg/m^3 in Upstairs Bunkroom, 0.00040 mg/m^3 in Laundry. All others: ND
Radon gas	EPA 4 pCi/L	Max 0.7 pCi/L
Silica, crystalline	REL 0.05 mg/m^3	Max 0.006 mg/m^3

PEL – Permissible Exposure Limit (WISHA) – 8-hr Time Weighted Average (TWA)
REL – Recommended Exposure Limit (NIOSH) – 10-hr TWA
EPA – Environmental Protection Agency Recommendation
NE – Not established
ND – Not detected

Arsenic: a naturally occurring metal that is often distributed widely in the environment from the exhaust from copper smelters. Skin and inhalation exposure to arsenic has been associated with cancer in humans.

Asbestos: a mineral fiber that has long been used in a variety of building construction materials for insulation and as a fire-retardant. Inhalation of asbestos increases the long-term risk of chest and abdominal cancers and lung diseases.

Benzene: a component of gasoline and other industrial solvents. Benzene has been demonstrated to increase the risk of leukemia (a blood cancer) in humans based on epidemiological studies.

Cadmium: Fumes are contacted during exposure to heated metals (plating operations, welding, etc.). Chronic inhalation may cause emphysema, kidney damage, or increased risk of cancer.

Chromium, hexavalent: Ferrochrome alloys have been associated with lung disease in humans and certain forms of chromium (VI) compounds have been found to increase the risk of respiratory cancer.

Diesel particulate matter (DPM): tiny solid particles produced from diesel-powered internal combustion engines, consisting of a solid core of carbon containing a soluble organic fraction, sulfates, and trace elements. The particles are generally less than 1 um in diameter and consequently can be inhaled deep into the lungs. Exposure to DPM increases the risk of lung cancer.

Polycyclic aromatic hydrocarbons (PAHs): standard products of combustion, including automobiles, trucks, airplanes, fires, and even charcoal broiled foods. Exposure to PAHs the risk of cancer.

Radon: a radioactive gas that comes from the natural decay of uranium that is found in some soils. Buildings above such soils may traps radon inside, where it can build up and lead to an increased risk of lung cancer.

Silica, crystalline: Silica, or silicon dioxide, is naturally occurring minerals like quartz, cristobalite, and tridymite. When grinded or abraded, the dust can cause silicosis, an inflammation of the lung tissue that can obstruct the flow of oxygen into the lungs and blood. Silica exposure most often occurs in people who work in construction, mining, sandblasting, stonecutting, abrasives manufacturing, glass manufacture, and pottery. In addition, silicosis patients are at an increased risk for getting tuberculosis, heart disease, lung cancer, and connective tissue disease.

B. Other Airborne Health Hazards

Prezant tested the air both inside and outside (for background comparison) for other known airborne health hazards. See Tables 2 and 3 for a list of agents tested and the results. All of the measured agents were below the specified Action Limit, except for temperature, relative humidity, and carbon dioxide. Descriptions of each health hazard follow Table 2. Laboratory certificates of analysis for the mold and bacteria are presented in Appendix C. Laboratory certificates of analysis for the lead, mercury, respirable dust, and VOCs are presented in Appendix D. Carbon monoxide measurements are displayed in Figure 1, carbon dioxide measurements are displayed in Figure 2, and temperature and relative humidity measurements are displayed in Figure 3.

Table 2 – Analytical and Measurement Results for Other Airborne Health Hazards

Health Hazard	Action Limit	Results
Carbon monoxide (CO)	25 ppm ACGIH	All measurements were well below the action limit. See Figure 1.
Carbon dioxide	1,000 ppm ASHRAE odor control guidance; 5,000 ppm OSHA PEL; 30,000 ppm OSHA 15-minute short-term exposure limit	Indoor levels exceeded 1,000 in Bunkroom and Paramedic Rooms at night, but did not exceed the OSHA limits. See Figure 2.
Temperature	68°–74° F (winter); 73°–79° F (summer), ASHRAE comfort guidance	Temperatures were outside of winter recommended range for various periods. See Figure 3.
Relative Humidity	30-50% ASHRAE comfort guidance	Relative humidity was outside of recommended range for various periods. See Figure 3.
Lead	PEL 0.05 mg/m^3	Max 0.0014 mg/m^3
Mercury	PEL 0.05 mg/m^3	Max 0.00051 mg/m^3
Mold	Substantially higher than outdoors	There is an absence of evidence to indicate the presence of mold growth affecting indoor air quality.
Bacteria	Bacterial levels substantially higher than outdoors. Endotoxin levels of approximately 10 ng/m^3 or greater represent the level at which health symptoms start to occur.	There is an absence of evidence to indicate the significant presence of bacteria in indoor air. However, see the results for bacteria in dust, Table 4. The highest concentration of endotoxins measured was approximately 0.12 ng/m^3
Respirable dust	PEL 5 mg/m^3	Max 0.3 mg/m^3
VOCs	Various	See Table 3 for summary of results.

Carbon monoxide (CO): CO is a gas formed from internal combustion engines and fires. It is toxic by reducing the oxygen carrying capacity of the blood. Exposure to concentrations above 1000 ppm can result in coma and death. Symptoms at lower levels include headache, dizziness, nausea, and drowsiness.

Carbon dioxide: This is a colorless odorless gas that is a normal component of the atmosphere, coming from the normal breathing of animals. It is generally present at about 350 ppm. When higher levels are present, it may be an indicator that inadequate air changes are occurring in an occupied structure.

Temperature: High temperatures can cause more accidents to occur because it lowers concentration levels. Dehydration caused by loss of fluids due to perspiration gives rise to cramps, headache, and fatigue. Heat stress causes symptoms of nausea, extreme tiredness, dizziness, clammy skin, racing pulse, fainting, and lower levels of concentration. Heat stroke occurs if the blood temperature exceeds 102°F and can cause confusion, incoherent speech, convulsions, organ damage, and possible death.

Humidity: Humid or damp conditions encourage the growth of mold and can cause discomfort to occupants. Low humidity can cause eye irritation and increase susceptibility to bacterial or viral illnesses.

Lead: a naturally occurring metal that can cause severe kidney, blood, neurological, and reproductive effects. Commonly found in older paints and in indoor firing ranges, where lead dust can be deposited on walls and floors.

Mercury: a naturally occurring metal that can cause severe neurological effects. Lead is commonly found in many batteries (electronic equipment, mobile telephones, portable computers, and emergency backup lighting), thermostats, and many types of lamps (fluorescent lights, mercury vapor, high-pressure sodium, and metal halide lamps).

Mold: Molds are forms of fungi found both indoors and outdoors. Outdoors, molds live in the soil, on plants, and on dead or decaying matter. Indoors, molds live on dirt and cellulose products such as wood and paper. Molds produce microscopic spores that spread easily through the air. Allergic reactions and irritation are the most common health effects for individuals sensitive to molds. Flu-like symptoms and skin rash may occur. Molds may also aggravate asthma. Infections from building-associated molds may occur in people with serious immune diseases. Most mold symptoms are temporary and eliminated by correcting the mold problem.

Bacteria: Bacteria are often found living in dirt and areas of moisture. Some bacteria are disease-causing, such as *Salmonella typhi* (the cause of typhoid fever), but most are relatively harmless to humans. Most bacterial health symptoms are temporary and eliminated by removing the bacteria or treating the patient with antibiotics. Endotoxin is considered the major bioactive agent of gram-negative bacteria and has been associated with respiratory symptoms and to complaints related to the indoor environment.

Respirable dust: airborne material that is capable of penetrating to the gas-exchange region of the lungs. Depending on the dust content, effects can range from irritation to severe diseases.

Volatile organic compounds (VOCs): are emitted as gases from certain solids or liquids. VOCs include a variety of chemicals, some of which may have short- and long-term adverse health effects. VOCs are emitted by a wide array of products including solvents, gasoline, paints and lacquers, paint strippers, cleaning supplies, pesticides, building materials and furnishings, copiers, printers, and adhesives.

Table 3 – Analytical Results for VOCs

Compound Name	Open Dirt Area	Beanery	Outside	Upstairs Bunkroom	Diesel Generator Area	Watch Office	Weight Room	Battery/ Slop Sink Room	PEL mg/m^3
Acetone	0.0120	0.12000	0.00170	0.05700	0.00500	0.03200	0.02200	0.01700	1800
Benzene	0.0250	0.00740	0.00680	0.00640	0.00600	0.00600	0.00600	0.00540	3
2-Butanone	ND	0.00410	ND	0.00330	ND	0.00230	0.00120	0.00110	590
Carbon Tetrachloride	0.0044	ND	0.00052	0.00030	ND	0.00048	0.00041	0.00037	12.6
Chloroform	ND	0.00460	ND	0.00150	ND	0.00220	0.00200	0.00650	10
Dichlorodifluoro methane	0.0079	0.00065	0.00150	0.00097	0.00100	0.00130	0.00120	0.00140	4950
4-Ethyl toluene	ND	0.00190	0.00130	0.00190	0.00150	0.00150	0.00130	0.00150	
Ethylbenzene	0.0072	0.00530	0.00410	0.00470	0.00410	0.00380	0.00370	0.00440	435
Freon 11	0.0047	0.00082	0.00130	0.00120	0.00110	0.00130	0.00130	0.00100	
4-Methyl-2-Pentanone	ND	0.00260	ND	0.00570	0.00059	0.00360	0.00160	0.00270	205
Methylene Chloride	ND	0.00053	ND	0.00160	0.00079	0.00120	0.00094	0.00110	87
Styrene	ND	0.00086	0.00070	0.00090	0.00074	0.00072	0.00074	0.00083	215
Tetrachloroethene	0.0052	0.00064	0.00058	0.00110	0.00060	0.00081	0.00066	0.00088	170
Toluene	0.0740	0.01900	0.01700	0.01700	0.01700	0.01700	0.01700	0.01500	375
1,1,1-Trichloroethane	ND	ND	ND	0.00065	ND	0.00046	0.00037	ND	1900
Trichloroethene	ND	0.00100	ND	0.00110	0.00071	0.00062	ND	0.00150	269
1,2,4-Trimethylbenzene	0.0160	0.00510	0.00400	0.00540	0.00500	0.00500	0.00490	0.00500	125
1,3,5-Trimethylbenzene	0.0050	0.00210	0.00130	0.00200	0.00160	0.00160	0.00150	0.00160	125
m,p-Xylene	0.0220	0.01300	0.01200	0.01200	0.01200	0.01200	0.01100	0.01100	435
o-Xylene	0.0120	0.00590	0.00450	0.00510	0.00470	0.00440	0.00420	0.00480	475
Total VOCs, in mg/m^3	0.1954	0.1955	0.0573	0.1298	0.0624	0.0983	0.0820	0.0831	

ND = not detected

Figure 1 - Carbon Monoxide Measurements

[Not included. Please see full Final Report for this figure]

Figure 2 - Carbon Dioxide Measurements

[Not included. Please see full Final Report for this figure]

Figure 3 – Temperature and Relative Humidity Measurements

[Not included. Please see full Final Report for this figure]

C. Other Known Health Hazards

Prezant tested surfaces, soils, or bulk materials inside (and outside, where appropriate, for background comparison) for other known health hazards. Most agents tested were below the Action Limit, except for lead in soil and on surfaces, bacterial growth in dust, settled dust, and PAHs in settled dust. See Table 4 for agents tested and results. Descriptions of each health hazard follow Table 4. Laboratory certificates of analysis for the mold and bacteria are presented in Appendix C. Laboratory certificates of analysis for the other tests are presented in Appendix D.

Table 4 – Analytical and Measurement Results for Other Known Health Hazards

Location or media	Compound	Action Limit	Results
Soil in basement	Lead	250 mg/kg (Wash. MTCA, Method A residential)	1,500 mg/kg in open soil area; covered soil area is below MTCA limit.
Basement walls and floors	Lead	40 ug/ft^2 (EPA residential)	Max 6,600 ug/ft^2.
Surfaces where fluorescent lights are stored or were broken	Mercury	Above detection limit.	ND
Fluorescent light ballasts	PCBs	Any leakage from ballast without "No PCB" label	PCB-containing ballasts observed in basement. No leakage observed.
Damp wood/paper or dust	Mold	Significant growth	None observed.
Damp surfaces or dust	Bacteria	Significant growth	Gram-negative bacteria > 1M CFU/g noted in several rooms: Max in TV Room 3.5M CFU/g.
Tiles, pipes	Asbestos	1% (EPA)	No additional asbestos-containing materials discovered other than those in original survey.
Settled dust	Components	Significant amount of non-expected substances (not pollen, paper, skin)	Carbon particles very common (10-25%)
Bunker gear storage areas, laundry area	PAHs	Above outdoor levels	Max: 3.7 ug/sample Outdoors: ND
Bricks	Sealant	None established for off-gassing	Methylene chloride: 0.0052 mg/m^3 Tentatively identified VOCs: Acetaldehyde; 2-Methyl butane; 2,4-Dimethyl heptane; 4-Methyl octane; Limonene; Nonanal + C4 substituted benzene; Decanal
Bricks	White crystalline material	None established for surface accumulations	Quartz, sodium sulfate, potassium sodium sulfate, calcite
Drinking water	Lead	EPA 0.015 mg/L	Max 0.002 mg/L
Radiofrequency (RF)		0.2 mW/cm^2 (47 CFR 1.1310) (FCC)	Roof: 0.11 mW/cm^2 directly below antenna. Bunkroom immediately below antenna: 0.03 mW/cm^2

Table 4 – Analytical and Measurement Results for Other Known Health Hazards

Location or media	Compound	Action Limit	Results
Pesticides	Organochlorine pesticides	DDT: 1,000 ug/kg[1] Chlordane: 500 ug/kg[2] Heptachlor epoxide: 70 ug/kg[2]	Hose Tower: DDT 11 ug/kg Outside Soils by E tree: Chlordane: 310 ug/kg Heptachlor epoxide: 67 ug/kg Outside soil in W planter: Chlordane: 400 ug/kg

ND: Not detected
[1] Washington Department of Ecology MTCA Method A Soil Cleanup Level
[2] EPA Residential Soil Cleanup Level

PCBs: generic term for a range of polychlorinated biphenyl compounds used commercially in heat transfer media and in the chemical/coatings industry. Prolonged skin contact with PCBs may cause acne-like symptoms, known as chloracne. Irritation to eyes, nose, and throat may also occur. Acute and chronic exposure can cause liver damage, and symptoms of edema, jaundice, anorexia, nausea, abdominal pains, and fatigue. PCBs are a suspect carcinogen.

Radio Frequency (RF): Radiofrequency (RF) radiation is electromagnetic radiation in the frequency ranges 3 kilohertz (kHz) - 300 Megahertz (MHz). Use of RF includes radios, cellular phones, and communications transmitters. The primary health effect of RF is a result of heating in deep body organs, but other effects are being studied.

Organochlorine Pesticides: Pesticides are a diverse class of chemicals used for the control and destruction of harmful or nuisance organisms. Although pesticides are found in nearly all classes of chemicals, the organophosphate, carbamate, and organochlorinated insecticides are perhaps among the most significant from an environmental and toxicological perspective. The organochlorine insecticides include such compounds as DDT, heptachlor, and chlordane. They can be toxic via inhalation of dusts, skin contact, and ingestion. They are also considered to be environmentally persistent chemicals. Although these insecticides are also classified as neurotoxins, they do not have a common or well-characterized mode of toxic action like the organophosphate or carbamate insecticides. Symptoms of organochlorine insecticide exposure include apprehensiveness, irritation, dizziness, tremors, and convulsions. Respiratory paralysis can result in death. Some of the organochlorine pesticides are considered potential carcinogens. The organochlorine insecticides have occupational exposure limits, with PEL-TWA values of 1 mg/m^3 for DDT, 0.25 mg/m^3 for dieldrin, and 0.5 mg/m^3 for lindane and chlordane.

D. Ionizing Radiation

This section presents the results of a screening level ionizing radiation survey conducted at Station 31. For comparison purposes, additional measurements were taken outdoors, in cars on the road, and in other unrelated structures. In addition, the average annual radiation received by people from medical/dental X-rays and the average annual radiation exposure to each person in the United States from all sources (natural and man-made) was researched for comparison purposes. Finally, the OSHA limits for occupational exposure to ionizing radiation exposure were investigated. These results, presented in Table 5, indicate that the radiation received by a firefighter working in Station 31 would be approximately the same as a person living in a red brick house in Seattle. The actual dose received by a firefighter would be even less, since a portion of their time during work is outside the station, where outdoor levels would apply. These levels are also well below OSHA occupational health standards for radiation exposure. Therefore, there is no reason for any precautions regarding radiation at the firehouse.

Table 5 – Ionizing Radiation Measurements

Location		Reading in uR	Time in hrs	mR/hr	mR/yr
Car	Eastlake Ave.	1.34	0.17	0.0077	68
Outdoors	~500 ft. from F.S. 31	0.74	0.08	0.0089	78
Car	Aurora Ave.	4.60	0.50	0.0092	81
Red Robin	University Bridge	10.60	1.14	0.0093	81
Outdoors	~50 ft. from F.S. 31	0.85	0.08	0.0102	89
Poured concrete office bldg	6th Ave N.	186.00	17.38	0.0107	94
F.S. 31	Beanery, center table	1.05	0.08	0.0127	111
Medical/dental x-rays per person					114
F.S. 31	Beanery, center countertop	237.00	17.98	0.0132	116
F.S. 31	Engine office	941.00	71.25	0.0132	116
F.S. 31	Watch office, countertop	1.12	0.08	0.0135	118
F.S. 31	Weight Room, desk	1.13	0.08	0.0136	119
F.S. 31	Battery/slop room, countertop	1.13	0.08	0.0136	119
F.S. 31	Ladder office, top of file cab. near desk	1.15	0.08	0.0139	122
Red brick home (int. & ext.)	N. Seattle, 125th & Dayton	166.40	11.67	0.0143	125
F.S. 31	Apparatus Room, 11' 9" from SE corner	1.19	0.08	0.0143	126
F.S. 31	TV Room, NE chair	1.24	0.08	0.0149	131
F.S. 31	Bunkroom, SE bed	1.28	0.08	0.0154	135
F.S. 31	Apparatus Room, 24" from SE corner	1.43	0.08	0.0172	151
F.S. 31	Apparatus Room, 9" from SE corner	1.57	0.08	0.0189	166
Avg. received per person in U.S.					312
OSHA Limit (pregnant women, during gestation period)					500
OSHA Limit (whole body, other than pregnant women)					5000

E. Carcinogens That Were Not Specifically Studied

The substances listed in Table 6 are known to be human carcinogens (National Toxicology Program, 10th Annual Report on Carcinogens). Carcinogens listed in **boldface** were tested, but the others were not, as they are unlikely to be present in Station 31 or are not appropriate chemicals for testing in this scope of work for the reasons stated.

Table 6 – Known Human Carcinogens

Chemical Name	Use and Reason for Not Including in This Study
Aflatoxins	substance found in moldy peanuts.
Alcoholic beverage consumption	personal habit.
4-Aminobiphenyl	not in general use in industry or commerce.
Analgesic mixtures containing pheacetin	prescription drug.
Arsenic compounds, inorganic.	
Asbestos.	
Azathioprine	prescription immunosuppressant drug.
Benzene.	
Benzidine and dyes metabolized to benzidine	manufacture and use of dyes.
Beryllium and beryllium compounds	manufacture of atomic weapons.
1,3-Butadiene	manufacture of certain rubber compounds.
1,4 butanediol dimethylsulfone	not in general use in industry or commerce.
Cadmium and cadmium compounds.	
Chlorambucil	prescription drug used to treat cancer.
MeCCNU	prescription drug used to treat cancer.
bis(chloromethyl) ether and technical grade chloromethyl methyl ether	not in general use in industry or commerce.
Chromium hexavalent compounds.	
Coal tar pitches and coal tar	roofing and road asphalting; essentially the same compounds as PAHs (soots).
Coke oven emissions	industrial coke production for the steel industry.
Cyclophosphamide	prescription drug used in cancer treatment.
Cyclosporin A	prescription drug used in cancer treatment.
Diethylstilbestrol (DES)	prescription drug formerly used to prevent morning sickness and miscarriage in pregnant women.
Erionite	naturally occurring fibrous mineral resembling asbestos, not in current use.
Estrogens, steroidal	prescription drug.
Ethylene oxide	used in sterilization of hospital equipment.
Melphalan	prescription drug used in cancer treatment.
PUVA	combination of psoralen (P) and long-wave ultraviolet radiation (UVA) used to treat several severe skin conditions.
Mineral Oils (untreated and mildly treated)	used in the manufacture of automobiles, airplanes and parts, steel products, screws, pipes, precision parts, transformers, brass and aluminum production, engine repair, copper mining, and newspaper and commercial printing.
Mustard gas	used in chemical warfare.
2-Naphthylamine	not in general use in industry or commerce, only used for research purposes.
Nickel compounds	component of stainless steel, superalloys (e.g., Inconel 600) or nonferrous alloys (e.g., cupronickel).
Radon.	
Silica, crystalline (respirable size).	
Solar and ultraviolet radiation	occurs outdoors and in tanning booths, blocked by glass windows.
Soots	**essentially the same compounds as PAHs.**
Strong inorganic acid mists containing	industrial processes involving acid baths.

Table 6 – Known Human Carcinogens

Chemical Name	Use and Reason for Not Including in This Study
sulfuric acid	
Tamoxifen	drug used to treat breast cancer that increases risk of uterine cancer.
TCDD (tetrachlorodibenzodioxin)	combustion product of pentachlorophenol and a contaminant in Agent Orange.
Thiotepa	prescription chemotherapeutic agent.
Thorium dioxide	used in high temperature ceramics, gas mantles, nuclear fuel, flame spraying, crucibles, medicines, nonsilica optical glass, thoriated tungsten filaments, and as a catalyst.
Tobacco smoking, environmental tobacco smoke, and smokeless tobacco	personal habit.
Vinyl chloride	used in severely regulated industrial processes and found as degradation product of chlorinated compounds in many municipal landfills.
Wood dust	generally from working with hardwoods used in fine furniture manufacture.

[APPENDICES – Not included. Please see full Final Report for these sections]